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NATIONAL DAM SAFETY PROGRAM. LAKE MONTOWESE DAM (MO 30151), MIS--ETC(U)
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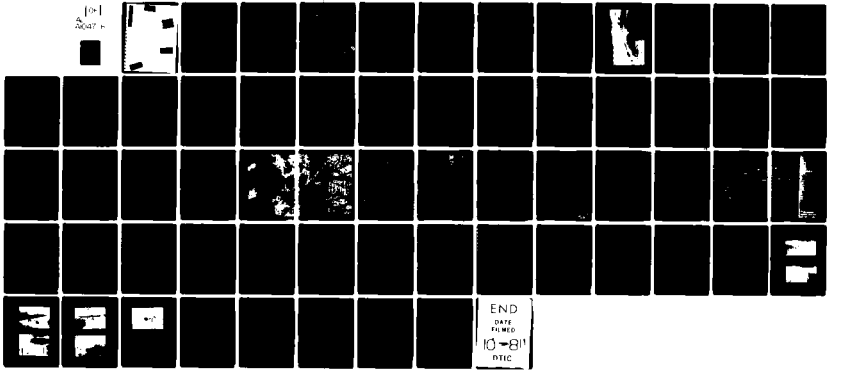

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lake Montowese Dam, Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Montowese Dam (Mo. 30151). It was prepared under the National Program of Inspection of Non-Federal Dams.

SIGNED

05 DEC 1979

SUBMITTED BY: _____ _____
Chief, Engineering Division Date

SIGNED

06 DEC 1979

APPROVED BY: _____ _____
Colonel, CE, District Engineer Date

LAKE MONTOWESE DAM
JEFFERSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30151

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

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FOR:

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

NOVEMBER 1978

HS-7848

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Lake Montowese Dam
State Located:	Missouri
County Located:	Jefferson
Stream:	Tributary Big River
Date of Inspection:	21 July 1978

The Lake Montowese Dam was visually inspected by engineering personnel of the office of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of the inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team.

Based on a visual inspection, the present general physical condition of the dam is considered to be satisfactory; however, the following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of the dam:

1. A few small trees exist on the upstream and downstream slopes of the dam. The downstream slope also has a dense cover of vegetation and brush in most areas that may contain animal burrows. The roots and animal burrows can provide passageways for seepage that may develop into a piping condition.

2. A dense growth of trees and brush obstructs the spillway outlet channel downstream of the roadway culvert crossing. This growth will restrict channel flow and could require spillway discharge to overflow the channel and flood the area adjacent to the downstream

toe of slope. Flooding of the area adjacent to the dam may impair the stability of the dam.

3. An 8-inch diameter concrete pipe, located approximately 340 feet south of the spillway, passes through the dam about 2 feet below the crest. This conduit will provide an outlet for lake surcharge at an elevation below the dam crest that could result in erosion of the downstream slope of the dam.

4. There did not appear to be a means of isolating the sanitary sewer passing through the dam should failure of the sewer line within the lake occur. Loss of water from the lake through the sewer pipe could surcharge the system to the point where it floods the area downstream of the dam. Operation of the lake can also be affected depending upon the quantity of lake water entering the sewer should failure occur.

According to the criteria set forth in the recommended guidelines (see text) the spillway design flood for this dam, which is classified as intermediate in size and of high hazard potential, is specified to be the probable maximum flood (PMF). PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Results of a hydrologic/hydraulic analysis indicated that the existing spillway is inadequate to pass lake outflow resulting from a storm of PMF magnitude. The spillway is capable, however, of passing lake outflow resulting from the 1 percent chance (100-year frequency) flood and lake outflow corresponding to about 45 percent of the PMF. The length of the downstream damage zone, should failure of the dam occur, is estimated to be five miles. Within the damage zone are ten homes and one multi-family dwelling.

A review of available data did not disclose that seepage and stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action in the near future to correct or control the deficiencies reported herein.

Albert B. Becker, Jr.

Albert B. Becker, Jr.
P.E. Missouri E-9168

OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE MONTOWESE DAM - ID NO. 30151

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE MONTOWESE DAM - ID. NO. 30151

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. National Dam Inspection Act, Public Law 92-367, dated 8 August 1972.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of the dam with respect to safety and, based upon available data and this inspection, determine if the dam poses a hazard to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams," Appendix to "Report of the Chief of Engineers on the National Program of Dams," dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Lake Montowese Dam is an earthfill type embankment that varies in height from 5 feet at the right (looking downstream) abutment (spillway) to approximately 50 feet at the left abutment. Lake level is governed by a concrete weir type spillway located adjacent to the right abutment. An access road to the Lake Montowese Subdivision with a culvert crossing the spillway outlet channel approximately parallels the dam. The culvert is located approximately 75 feet downstream of the spillway weir. The subdivision lots surrounding the lake are for the most part occupied by homes and other forms of improvements. A sanitary sewer serving the Lake Montowese Subdivision is located within the lake and passes

through the dam at a point about 225 feet from the centerline of the spillway channel. A pipe drain for partially dewatering the lake also passes through the dam at this location. At normal pool level the lake surface occupies approximately 40 acres. The upstream slope of the dam above and below the normal waterline is protected by riprap. A plan of the Lake Montowese Subdivision showing the lake and dam is shown on Plate 2.

b. Location. The dam and lake are located on an unnamed tributary of Big River, approximately 1 mile east of Byrnes Mill, Missouri, in Jefferson County, as shown on the Regional Vicinity Map, Plate 1. The dam is located in Section 27, Township 43 North, Range 4 East, approximately one-half mile west of the intersection of Lake Montowese Road and State Route 30.

c. Size Classification. The classification for size based on the height of the dam and storage capacity is categorized as intermediate. (Per Table 1, Recommended Guidelines for Safety Inspection of Dam.)

d. Hazard Classification. According to the St. Louis District, Corps of Engineers, the Lake Montowese Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, serious damage to homes, extensive agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, as determined by the St. Louis District, extends five miles downstream of the dam. Within the possible damage zone are ten homes and one multi-family dwelling.

e. Ownership. The lake and dam are owned by the Lake Montowese Development Company, Inc. The current president, Mr. Kenneth Garland, resides at 3649 South Lake Shore Drive, House Springs, Missouri, 63051.

f. Purpose of Dam. The dam impounds water for the purpose of recreation for the Lake Montowese Subdivision property owners.

g. Design and Construction History. The dam was constructed about 1942. The name of the builder of the dam could not be determined by Horner & Shifrin. According to information appearing on the Lake Montowese Subdivision Plat and obtained from the Jefferson County Courthouse, the property was filed for record by the Lake Montowese Development Company, Inc. in May of 1941. In 1943, at the request of the owner, Horner & Shifrin was retained to investigate the adequacy of the spillway. Certain improvements to the then 30-foot wide spillway and dam were recommended by Horner & Shifrin and subsequently carried out by the owner.

In 1970, the culvert crossing the spillway outlet channel just downstream of the weir was constructed replacing a concrete slab which forded the channel.

In 1974, Metropolitan Engineering Company of Arnold, Missouri, designed a sanitary sewer system, replacing septic tanks, to serve the subdivision area. The sewer system and a drain line for partially dewatering the lake were installed by the Bloomsdale Excavating Co., Inc. of Bloomsdale, Missouri. The tunneling work, including installation of the casing pipe and grouting of the annular space about the carrier pipes, was performed under subcontract by the Karston Equipment Co. of St. Louis County, Missouri. Also, in 1975, under the direction of the owner, Bloomsdale Excavating Company improved the spillway by increasing the section at the weir to its present width of 50 feet.

h. Normal Operational Procedure. The lake level is unregulated.

1.3 PERTINENT DATA

a. Drainage Areas. The areas adjacent to the lake are primarily suburban residential in the vicinity about the lake. The upper portion of the watershed is virtually undeveloped, with the exception of a few scattered homes, and covered with timber. The watershed area above the dam amounts to approximately 500 acres.

b. Discharge at Damsite.

(1) Estimated maximum flood at damsite ... Unknown(1)

(2) Spillway capacity ... 1,570 cfs

c. Elevation (ft. above MSL). The invert elevation (537.24) of the manhole for the sanitary sewer, located approximately 225 feet south of the centerline of the spillway channel and about 25 feet west of the centerline of the road adjacent to the dam, was used as a benchmark for determination of the elevations included herein. The invert elevation of the manhole was obtained from drawings of the sewer prepared by Metropolitan Engineering Company, see Plate 3.

(1) Top of dam ... 560.5 (min.)

(2) Normal pool (spillway crest) ... 556.0

(3) Streambed at centerline of dam ... 507± (est.)

(4) Maximum known tailwater ... 504.7(2)

d. Reservoir

(1) Length of maximum pool (elevation 560.5) ... 3,200 ft.

(2) Length of normal pool (elevation 556.0) ... 2,700 ft.

e. Storage.

(1) Normal pool ... 606 ac. ft.

(2) Top of Dam (incremental) ... 194 ac. ft.

f. Reservoir Surface.

(1) Top of dam ... 48 acres

(2) Normal pool ... 41 acres

g. Dam. Data tabulated below per survey made on date of inspection unless otherwise indicated.

(1) Type ... Earthfill

(2) Length ... 1,000 ft.

(1) According to a representative of the Owner, since 1975 when the spillway was improved (widened from 30 to 50 feet) there has been no significant lake outflow.

(2) Water surface level of pond at date of inspection. Pond located approximately 240 feet downstream of dam centerline at station 7+15± and between dam and spillway outlet channel.

(3) Height ... 50 ft.

(4) Top Width ... 18 ft.

(5) Side Slopes

(a) Upstream ... 1v on 1.7h at riprap[1]

(b) Downstream ... 1v on 2.2h above elevation 546±
1v on 2.7h below elevation 546±

(6) Cutoff ... Core trench, 10 feet wide (per specifications)

(7) Core wall ... Unknown

(8) Slope Protection

(a) Upstream ... Stone riprap

(b) Downstream ... Grass

h. Spillway.

(1) Type ... Concrete, unregulated

(2) Length of weir ... 50 ft.

(3) Crest elevation ... 556.0

(4) Upstream channel ... Lake

(5) Downstream channel ... Rock and earth cut sections

i. Outlet for Lake Drawdown ... Partial drawdown only.

(1) Type ... Pipe, PVC

(2) Size ... 6-inch

(3) Elevation at lake ... 542.8±[2]

(4) Control ... Gate valves upstream and downstream of dam.[2]
Existence of upstream valve not verified since valve location was below lake surface at time of inspection.

(1) Original specifications indicate upstream embankment slope to be 1v on 2.5h.

(2) As indicated on drawing by Metropolitan Engineering Co., see Plate 3.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No engineering data relating to the design of the dam or the hydraulics of the present spillway are known to exist. The investigation by Horner & Shifrin in 1943 to determine the adequacy of the 30-foot wide spillway is no longer valid since the spillway was improved (width increased to 50 feet) in 1975.

2.2 CONSTRUCTION

The dam was constructed about 1942. The only data available regarding construction of the dam consists of an incomplete (page 1 of 11 pages is missing) set of specifications. The specifications required a "puddle" ditch, 10 feet wide, approximately 5 feet deep and located near the centerline of the dam, to be excavated through the overburden to bedrock (sandstone) beginning at the north (right) end of the dam. A core, 3 feet deep and 5 feet wide, was also to be constructed in the sandstone for the purpose of keying the section into rock. Compacted clay backfill was specified for re-filling of the excavation. At the south bank (left abutment) specifications required a core trench, approximately 15 feet deep and 10 feet wide, to be cut into the sandstone. All material for construction of embankment was to be obtained locally. Borrow excavation was not permitted from the downstream side of the dam, or within 50 feet of the toe of slope on the upstream side, or deeper than 5 feet within 100 feet of the toe of slope. Embankment was specified to be constructed of clayey material, placed in layers not over 12-inches thick, and compacted by rollers having a weight of 300 pounds per inch of width. It was also specified that the finished crest of the dam be constructed to an elevation above that indicated on the plans by an amount equal to 5 percent of height of dam at the centerline. According to the specifications, excavation for the

spillway was classified as earth, loose rock, and solid rock. Since records of the actual construction were unavailable for review, it was not feasible to determine the extent to which the specifications were followed during construction of the dam and spillway.

2.3 OPERATION

According to a representative of the Owner, since improving the spillway in 1975 there has been no significant lake outflow due to rainfall runoff.

During the period from 1970 through 1976, the dam has been inspected numerous (seven reports are on file) times by representatives of the Missouri Geological Survey (MGS). These inspections and subsequent reports, reference Charts 2-1 through 2-11, were primarily for the purpose of advising the owner regarding maintenance of the dam and spillway. Based on the recommendations of the MGS, several improvements, including widening of the spillway, were made. A summary of major improvements recommended by MGS and accomplished by the owner during this period is as follows:

a. Provide a collection system in order to drain the flow emerging from the spring located in the rock fissure immediately downstream of the left abutment of the dam.

b. Place additional fill on the soft, water saturated area adjacent to the downstream toe of slope in order to prevent lake seepage from emerging at this location.

c. Improve the capacity of the spillway such that it affords a greater degree of protection against overtopping of the dam. It was also recommended that a consultant, experienced in hydrology and the design of spillways for earthfill type dams, be retained in order to

advise the owner on the nature and extent of these spillway improvements. (Widening of the spillway was done under the direction of the owner without specific engineering advice.)

Other recommendations made by MGS and implemented by the Owner consisted of removing trees from the dam area, removing muskrats and filling burrows in the dam face, and replacing riprap at the lake waterline where missing.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillway were not available.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the dam and spillway was made by Horner & Shifrin engineering personnel on 21 July 1978. Also inspected at this time was the area downstream from the dam including the two road stream crossings between the dam and Big River. Photographs of the dam and spillway taken at the time of the inspection are included on Pages A-1 through A-4 of the Appendix.

b. Dam. The visible portions of the upstream and downstream slopes (see Photos 1 and 2) of the dam appeared to be in satisfactory condition, although a few small trees were present in each location and a heavy cover of vegetation exists on most of the downstream slope. Riprap, consisting of limestone rock, was present on the upstream face of the dam above and below the normal waterline. An 8-inch concrete pipe, approximately 30 feet long, exists in the dam about 2 feet below the crest approximately 340 feet south of the spillway. According to the owner, this pipe once housed a smaller pipe that was part of a system used to dewater the lake. At present the pipe serves no purpose. The 6-inch pipe subdrain, installed by the owner to collect flow from the spring located in the left abutment just below the dam, was observed at its outlet point adjacent to the road. The upstream end of the subdrain could not be located due to the heavy cover of vegetation in this area. At the time of the inspection there was no flow in the pipe. An 8-inch pipe culvert crosses the road immediately downstream of the subdrain outlet. A minor quantity, estimated to be about 1 gpm, was flowing from the culvert at the downstream end. The flow was clear and there were no deposits of sediment at this location. A small pond (see Photo No. 7) of perhaps one-half acre in size is located just west of the road, about 240 feet from the centerline of the dam and approximately 730 feet south of the spillway weir. A dike separates the pond from the stream that serves the spillway outlet channel.

The elevation of the top of the dam, as determined by survey, was found to vary by about 1.3 feet with the lowest point located approximately 320 feet from the spillway. A profile of the dam crest extending through the spillway is shown on Plate 4.

c. Spillway. The concrete weir spillway (see Photo 3) appeared to be in good condition. No deterioration of the concrete due to weathering or damage from ice was noticed. Some minor flow (1± gpm) was noticed in the spillway channel (see Photo 4) just downstream of the concrete apron below the weir. It appeared that this flow was due to seepage beneath the concrete weir and apron section. The left bank of the spillway channel between the dam and the culvert, located downstream of the weir, was protected with concrete slope paving. The right bank was turf covered. An 18-foot wide, four-cell concrete culvert (see Photo 5), bridges the spillway channel approximately 75 feet downstream of the weir. The culvert structure was found to be in good condition. The spillway outlet channel between the culvert and the original stream course (see Photo 6) was overgrown with a heavy cover of brush and small trees. A profile of the spillway channel from the weir to the culvert is shown on Plate 3.

d. Downstream Channel. The downstream channel is unimproved. The stream joins the Big River at a point about 2 miles downstream of the dam.

e. Reservoir. The area surrounding the lake is nearly entirely occupied by homes and other improvements. Concrete walls serve to protect the shore line at many locations. A beach for swimming is located at the upstream end of the lake. According to a representative of the Owner, there is no appreciable sediment in the lake at the present time since most of the deposited material was removed at the time when the sanitary sewer system was installed.

f. Sanitary Sewer and Lake Drawdown Pipe. The manhole for the sanitary sewer passing through the dam at a point approximately 225 feet south of the spillway channel and located about 10 feet west of the road was inspected and

found to be in good condition. There was no evidence of a valve on the sewer line at the location shown on the drawing (see Plate 3) prepared by the Metropolitan Engineering Co. Depth of flow in the sewer at around 8:00 a.m. was about 0.10 foot. The valve located on the 6-inch lake drawdown pipe and the outlet end of the pipe were also inspected. The valve with cast-iron curb box and lid appeared to be in good condition. No flow was being discharged at the outlet end of the pipe located at the stream bank.

3.2 EVALUATION

The deficiencies observed during this inspection are not considered significant to warrant immediate remedial action.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The water surface level is governed by rainfall runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM AND SPILLWAY

According to a representative of the Owner, the grass on the dam crest and the area adjacent to the downstream toe of slope is mowed frequently throughout the growing season. It was also reported that trees appearing in the upstream and downstream faces of the dam are cut to ground level once a year. The vegetation on the downstream slope is not cut. Due to the relatively recent (1975) improvements made to the spillway, little maintenance of the spillway features has been necessary. Concrete slope paving has been periodically placed on the left bank of the spillway channel between the weir and culvert to protect the slope.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No spillway control facilities exist at this dam. The valve on the lake drawdown pipe, installed in 1975, was closed and not leaking at the time of the inspection.

4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

The inspection did not reveal the existence of a dam failure warning system.

4.5 EVALUATION

A properly maintained dam is considered beneficial to the safety of the dam. It is recommended that maintenance of the downstream slope of the dam include cutting the brush, and that maintenance of the spillway outlet channel downstream of the roadway culvert be included along with the other normally maintained features.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data are not available.

b. Experience Data. The drainage area and lake surface area were developed from the U.S.G.S. House Springs, Missouri, Quadrangle Map. The proportions and dimensions of the spillway and dam were developed from surveys made during the inspection.

c. Visual Observations.

(1) The 12-inch wide by 50-foot long concrete weir crest section is in good condition. Concrete paving on the bottom of the spillway approach channel extends about 5 feet upstream of the weir crest. Concrete paving on the bottom of the discharge channel extends 15 feet downstream from the weir crest. A four-cell reinforced concrete box culvert for the road crossing the outlet channel is located about 75 feet downstream of the weir. Concrete slope paving extending from the dam to the culvert is provided on the left (dam) bank of the spillway channel. Downstream of the road culvert the discharge channel is obstructed with small trees and brush.

(2) According to the drawing prepared by the Metropolitan Engineering Co. (see Plate 4), a 6-inch diameter pipe (polyvinylchloride pipe through the dam and cast iron pipe upstream and downstream of the dam) with 6-inch gate valves above and below the dam is provided to partially unwater the lake to about elevation 542.8. This drain pipe, together with a 10-inch diameter ductile iron pipe sanitary sewer, is installed in a 26-inch diameter steel casing pipe extending through the dam and under the road downstream of the dam. Due to the fact that the piping on the upstream side of the dam was submerged at the time of the inspection, the as-built condition of these pipe lines could not be determined. As indicated in Section 3, paragraph 3.1f, the

downstream valve on the lake drawdown pipe was located; however, the valve on the sewer pipe, just upstream of the sanitary sewer manhole, could not be found.

(3) The spillway and outlet channel are located at the right abutment of the dam. Spillway releases, within the capacity of the spillway section, will not endanger the integrity of the dam.

d. Overtopping Potential. The spillway section is inadequate to pass the probable maximum flood or the 1/2 probable maximum flood without overtopping the dam, but is adequate to pass the 1 percent chance (100-year frequency) flood without overtopping the dam. The results of a dam overtopping analysis are as follows:

Ratio of PMF	Q - Peak Outflow (cfs)	Max. Lake Water Surface Elevation	Maximum Depth of Flow Over Dam (Elev. 560.5)	Duration of Overtopping of Dam (Hours)
0.45	1,570	560.5	0	0
0.50	1,830	560.9	0.4	0.7
1.0	7,600	562.7	2.2	3.1
100-Year Flood	550	558.3	0	0

The flow safely passing the spillway just prior to overtopping amounts to about 1,570 cfs, which is equivalent to the outflow from about 45 percent of the probable maximum flood inflow, and exceeds the outflow from the 1 percent chance (100-year frequency) flood.

Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curve for flow over the spillway and the dam crest are presented on Pages B-1 and B-2 of the Appendix. A listing of the HEC-1DB input data is shown on Pages B-3 through B-5 of the Appendix.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. With the possible exception of the pond located in the area near the downstream toe of the dam, there was no evidence nor conditions observed during the visual inspection which might adversely affect the structural stability of the dam.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist.

c. Operating Records. With the exception of the gate valve on the lake drawdown pipe, no appurtenant structures or facilities requiring operation exist at this dam. According to a representative of the Owner, no records have been kept of lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. According to a representative of the Owner, the dam was raised sometime in the 40's. The extent of the additional material or the elevation to which the dam was raised are unknown. The improvements to the spillway made in 1975, consisting primarily of widening the section from 30 to 50 feet, do not adversely affect the structural stability of the dam.

e. Seismic Stability. Since the dam is located within a Zone II seismic probability area, an earthquake of the magnitude predicted is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated the concrete spillway to be capable of passing lake outflow of about 1,570 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicated that for a storm runoff of probable maximum flood magnitude, the lake outflow would be on the order of 7,600 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 550 cfs.

No stability and seepage analyses of the dam, nor hydraulic analyses of the spillway, are known to exist. Further, it was noticed during the visual inspection that a pond is located in the area below the dam, at a point about 105 feet from the toe of slope. The possibility exists that the presence of this pond may affect the structural stability of the dam in the vicinity of the pond since the mass of earth resisting movement of the embankment is reduced.

b. Adequacy of Information. Due to the lack of engineering and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessment of the hydrology of the watershed and capacity of the spillway were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The items concerning the safety of the dam noted in paragraph 7.1a and the remedial measures recommended in paragraph 7.2 should be accomplished in the near future since failure of the dam could result from overtopping or instability.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. Since the dam is located within a Zone II seismic probability area, an earthquake of the magnitude predicted is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

(1) Based upon criteria set forth in the recommended guidelines, alterations to the design of the dam should be made in order to pass lake outflow resulting from a storm of probable maximum flood magnitude.

(2) Obtain the necessary soil data and perform stability and seepage analyses in order to determine the structural stability of the dam for all operational conditions. The presence of the pond in the area adjacent to the downstream toe of slope should be included in the evaluation of the dam stability. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

(3) According to the drawing prepared by Metropolitan Engineering Co., there appears to be no way to isolate the section of sanitary sewer passing through the dam should failure of the pipe under or upstream of the dam occur and lake water enter the pipe. Further, as indicated in Section 3, the valve, as shown on the drawing by Metropolitan and located immediately upstream of the manhole on the sanitary sewer line passing through the dam, could not be found at the time of the inspection. The owner should address these deficiencies and take the necessary corrective measures.

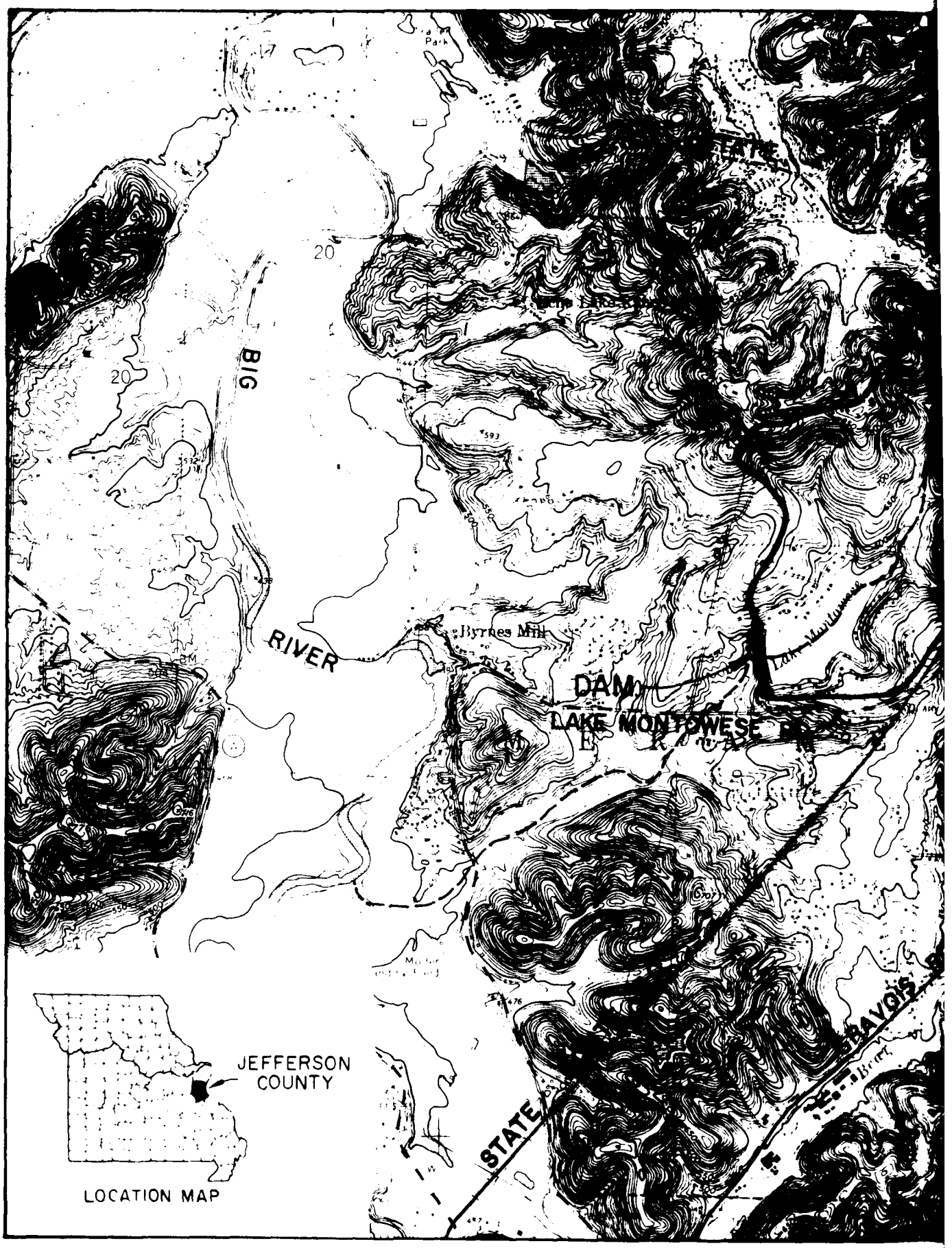
b. O & M Maintenance and Procedures. The following O & M Maintenance and Procedures are recommended:

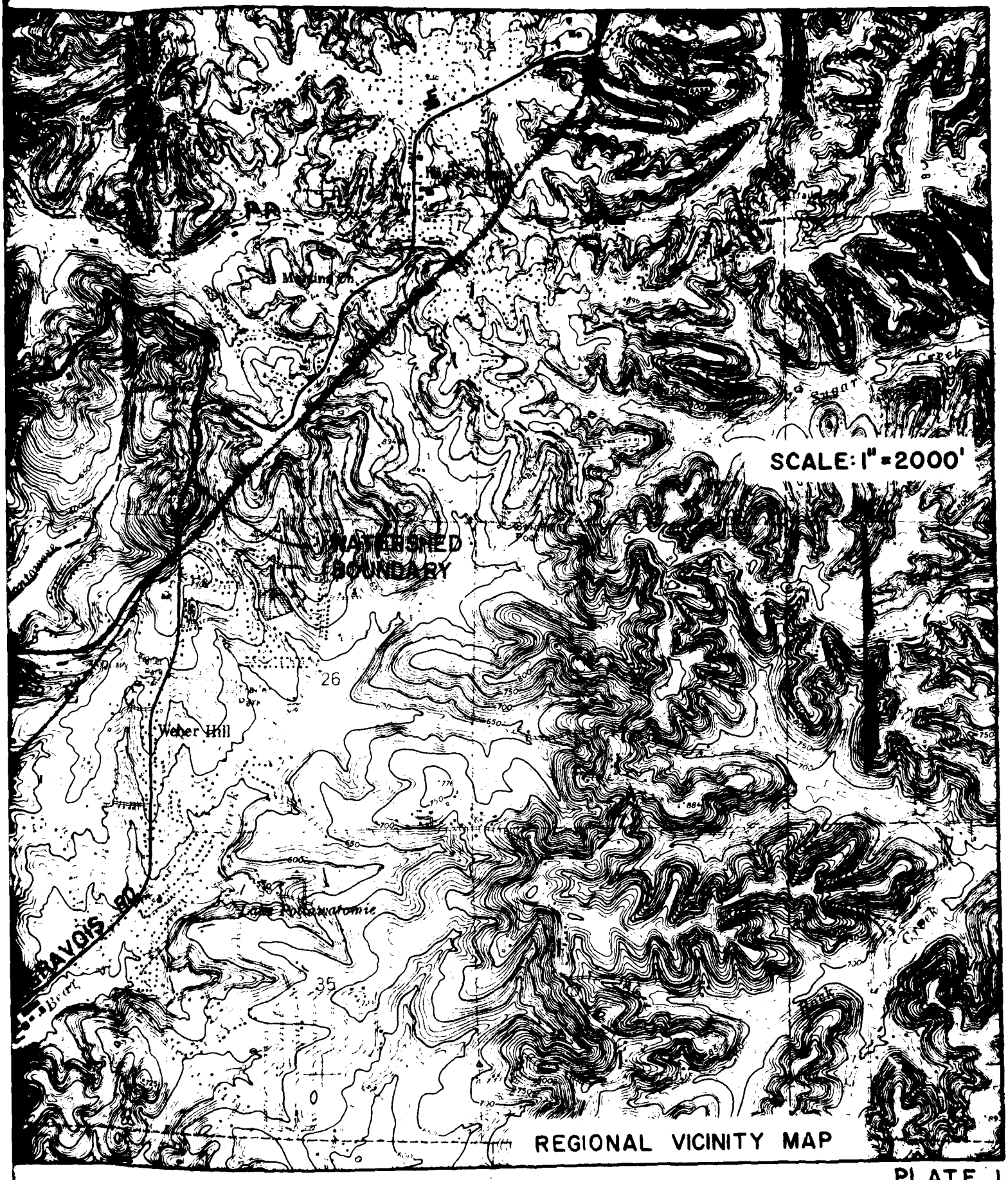
(1) Remove the small trees present in the upstream and downstream slopes of the dam. It is also recommended that the brush be removed and the dense vegetation existing on the downstream slope be thinned in order to reduce conditions considered attractive to burrowing animals. Voids created by burrowing animals and tree roots can provide pathways for seepage and the possibility of piping.

(2) Remove the trees and brush from the spillway channel section downstream of the culvert in order to allow spillway flow to reach the downstream channel unrestricted. Restricting spillway discharge can result in flooding of the area adjacent to the downstream toe of dam and conditions detrimental to the stability of the embankment.

(3) Plug or remove the 8-inch pipe, passing through the dam about 2 feet below the crest and located approximately 340 feet south of the spillway, in order to prevent lake outflow through this conduit and erosion of the downstream slope.

(4) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections and remedial measures.


BIG
RIVER
Byrnes Mill
DAM
LAKE MONTOWESE
STATE
BAYOU
JEFFERSON
COUNTY
LOCATION MAP



REGIONAL VICINITY MAP

PLATE 1

SUBDIVISION NO. ONE OF

LAKE MONTOWESE

HOUSE SPRINGS

JEFFERSON COUNTY

MISSOURI

State of Missouri, }
} ss
County of Jefferson }

Be it remembered that the Lake Montowese Development Company, Inc., a corporation organized and existing under the laws of the State of Missouri, hereby certifies that it is the owner of the land comprising Subdivision No. One of Lake Montowese, a subdivision located in a part of Sections 23 and 27, Township 43 North, Range 4 East; that it has caused the same to be surveyed and subdivided in the manner shown hereon, said subdivision is subject to the lien of deeds of trust recorded in Trust book 161 page 203 and in Trust Book 161 page 204

The Lake Montowese Development Company, Inc., reserves the title to all roadways, pathways and parkways surrounding the lake.

The restrictions reserved by deed of restrictions executed by said corporation, of even date herewith, recorded in the Recorder's office within and for Jefferson County, Missouri, in Book 164 page 366, are hereby accepted and made binding upon this subdivision.

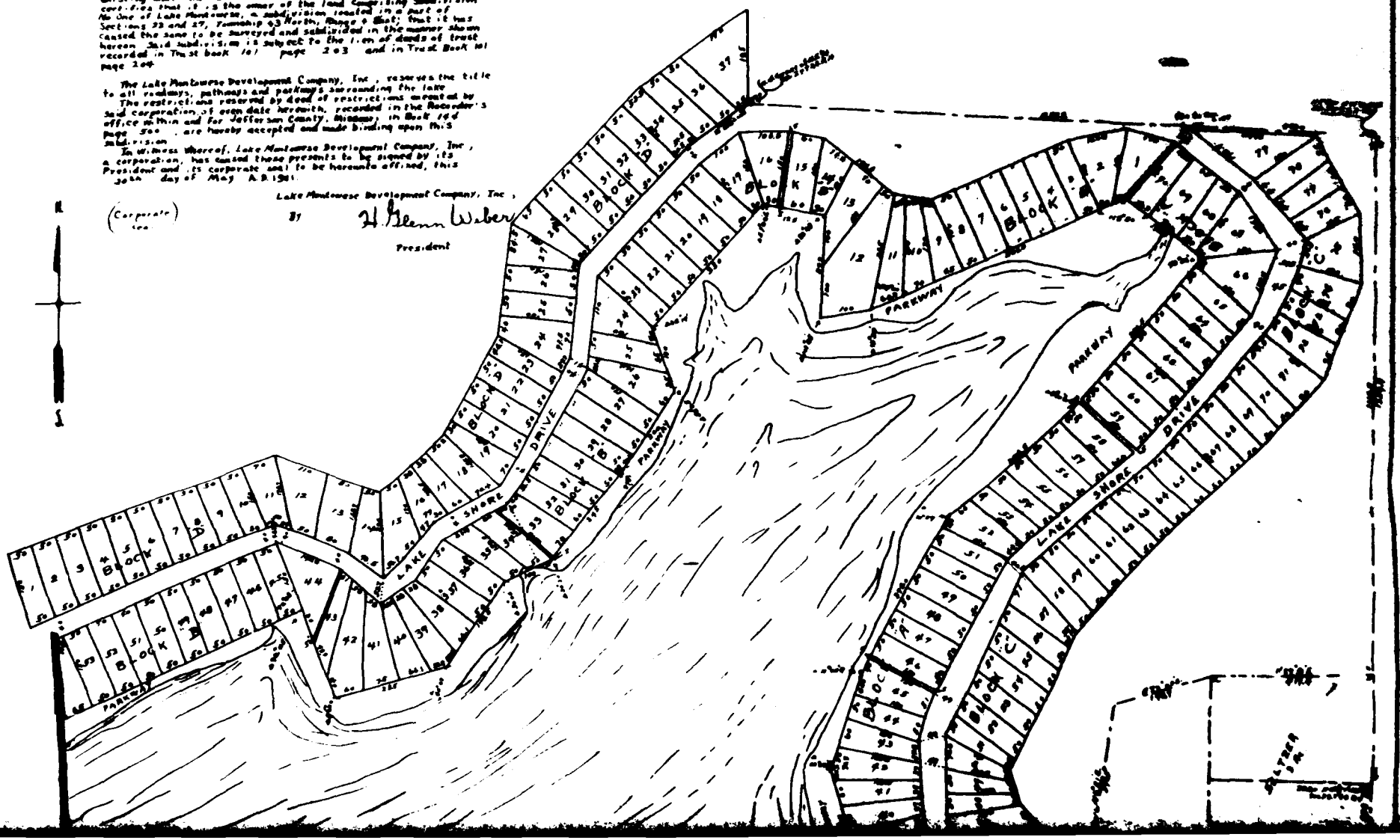
In Witness Whereof, Lake Montowese Development Company, Inc., a corporation, has caused these presents to be signed by its President and its corporate seal to be hereunto affixed, this 30th day of May A.D. 1961.

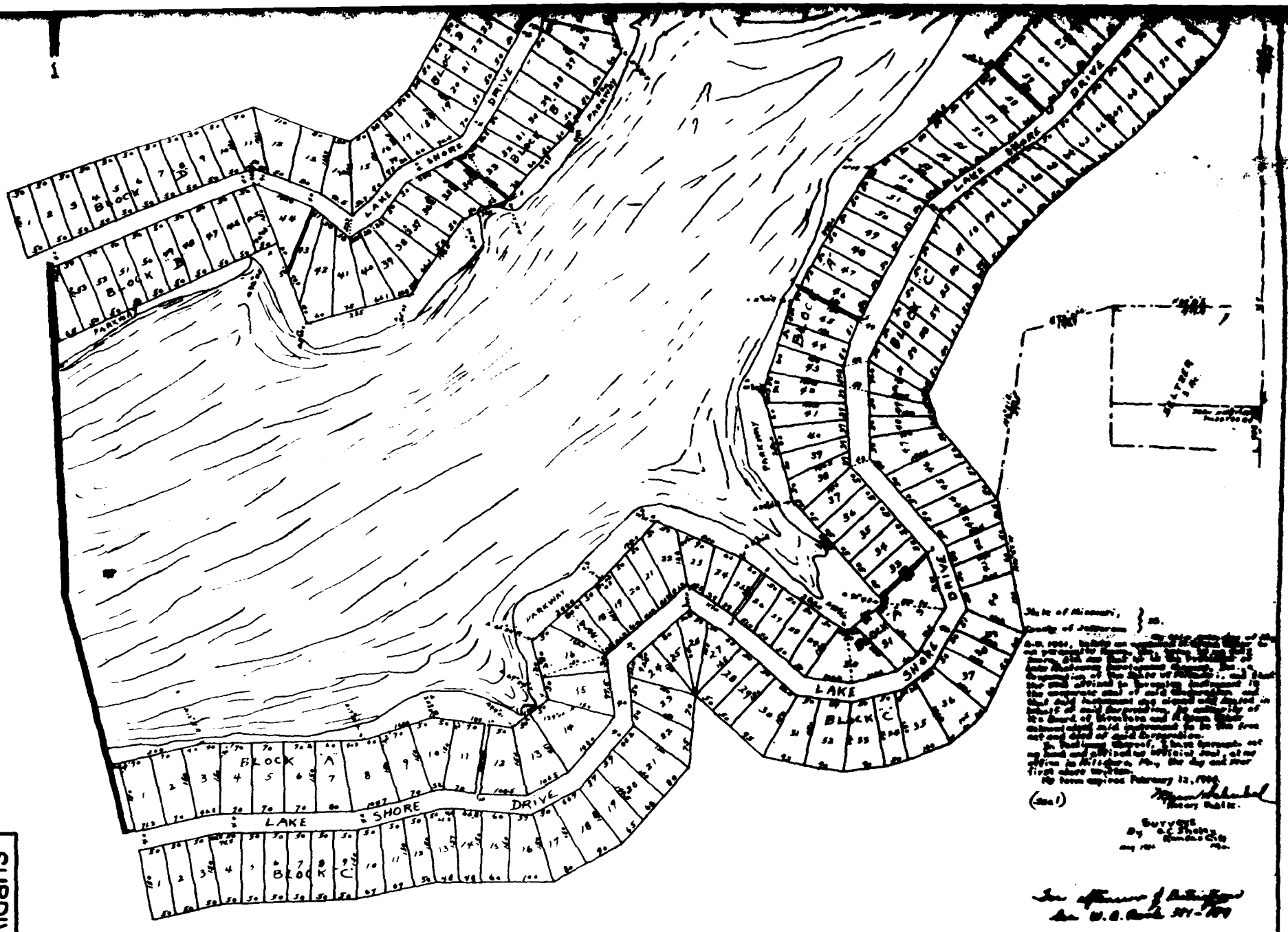
Lake Montowese Development Company, Inc.,

(Corporate Seal)

By H. Glenn Weber

President

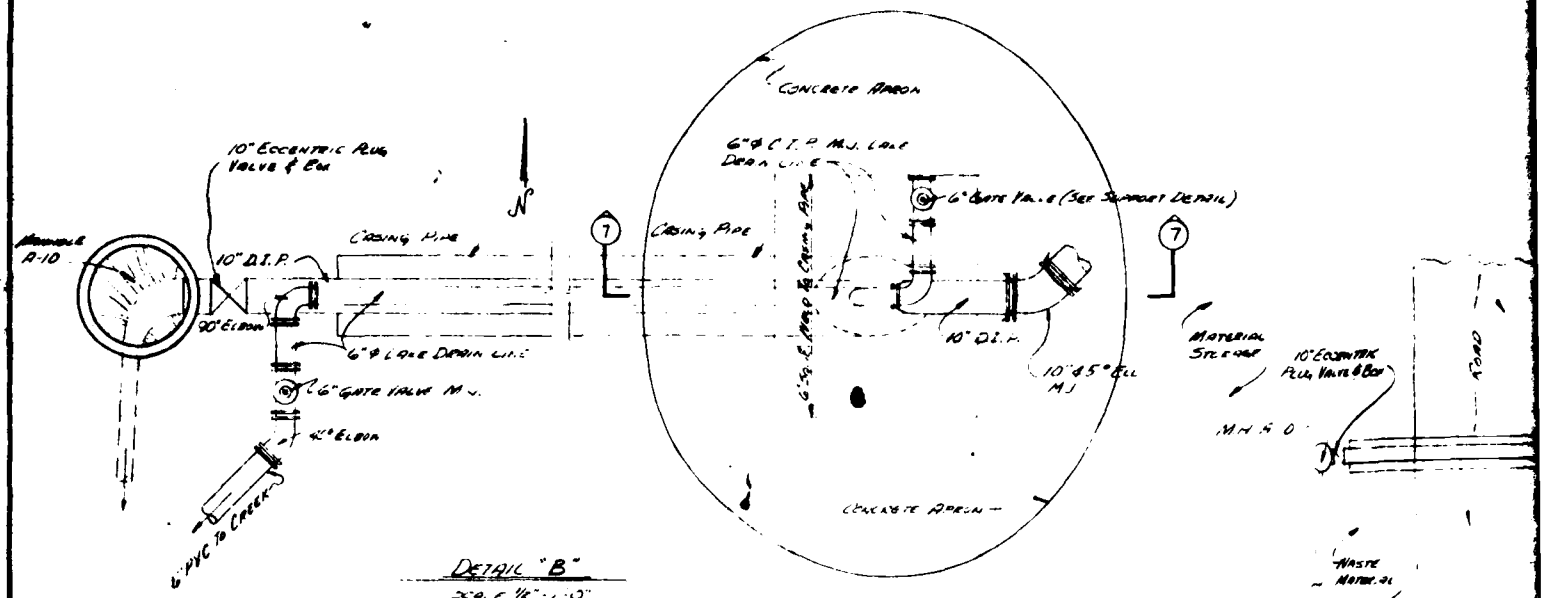




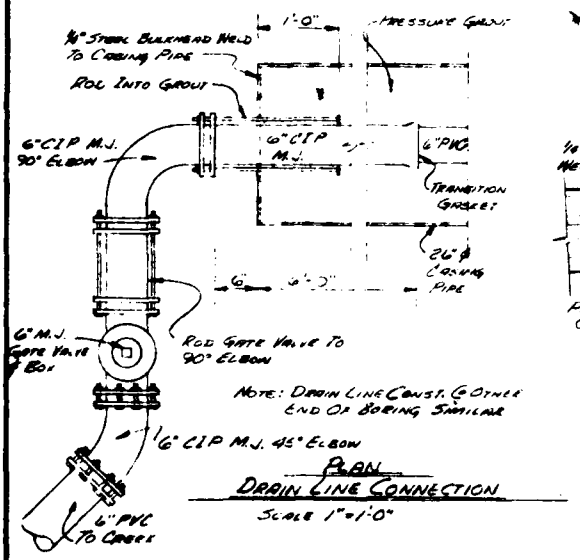
SUBDIVISION PLAT

PLATE 2

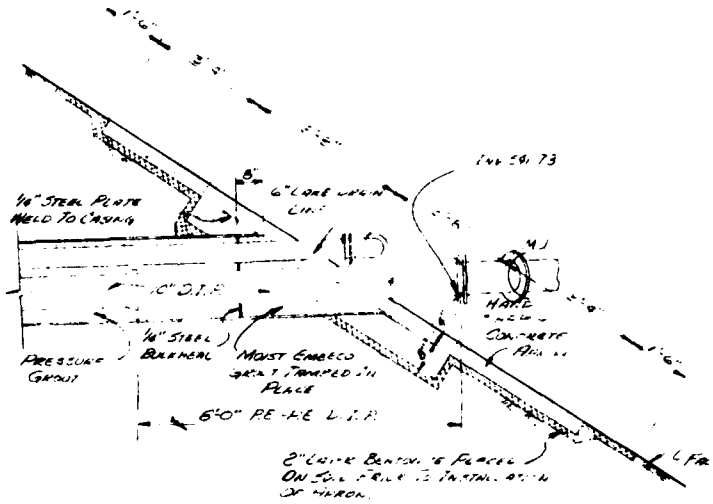
Filed for Record this 20th day of May A.D. 1941 at 10 o'clock 6 minutes P.M.
By Vesta Ellis Robert Deputy
Lloyd Wilson, Recorder



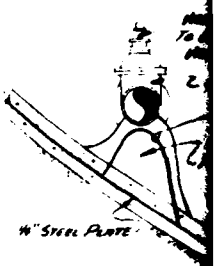
DETAIL "B"
SCALE 1/4" = 1'-0"



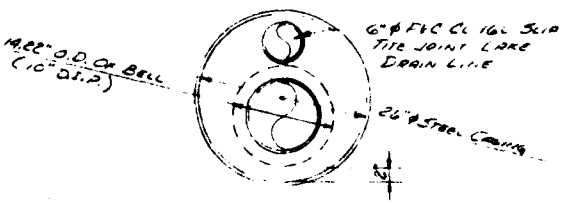
PLAN
DRAIN LINE CONNECTION
SCALE 1" = 1'-0"



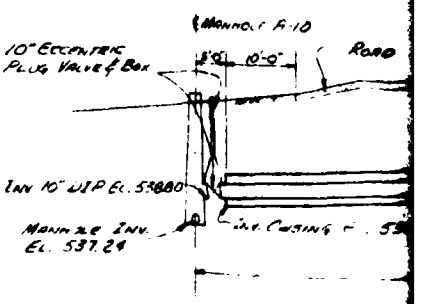
SECTION 7
SCALE 1/8" = 1'-0"



GATE VALVE SUPP
NOT TO SCALE

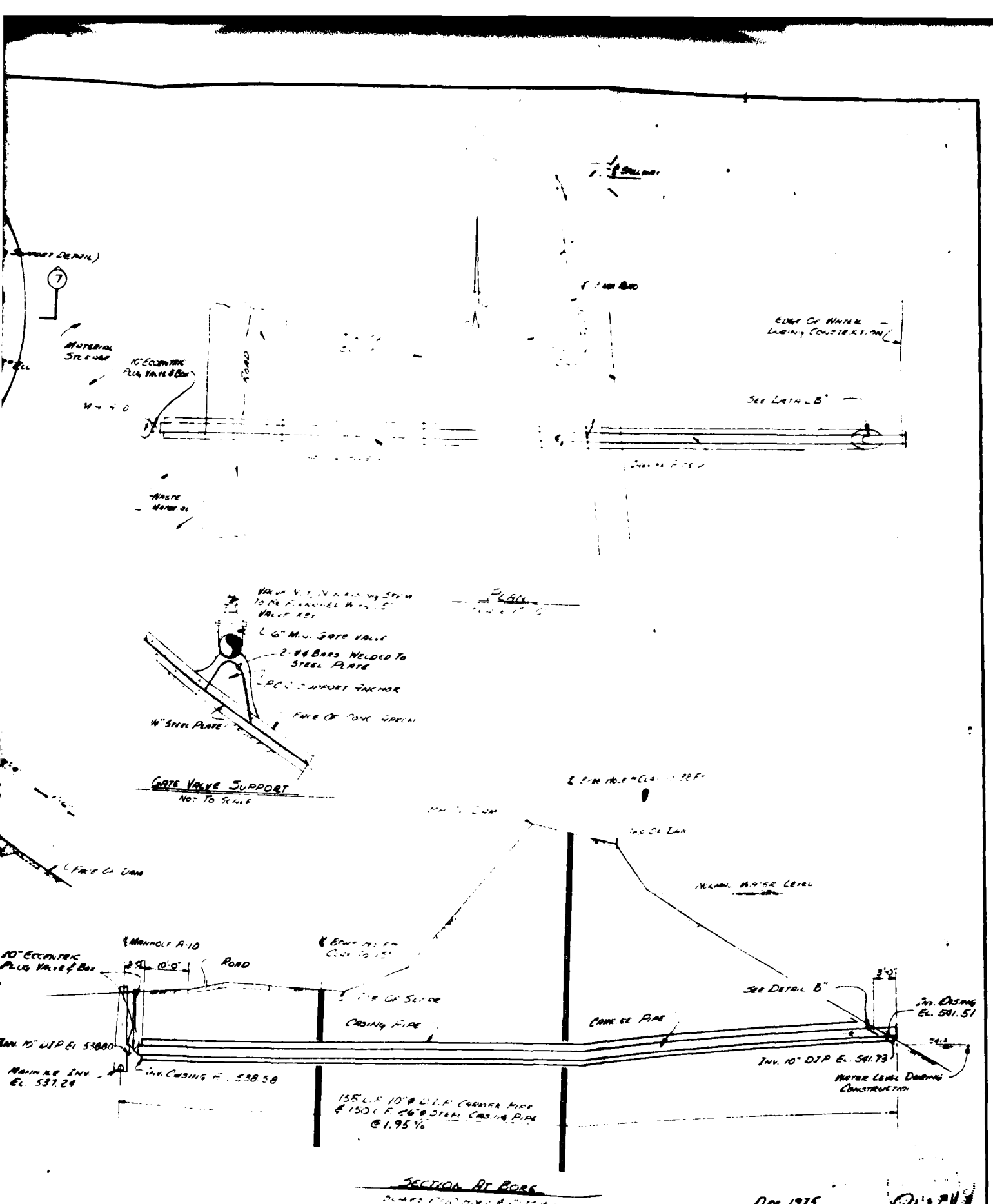


SECTION THRU CASING
SCALE 1" = 1'-0"



METROPOLITAN ENGINEERING CO.
consulting engineers and land surveyors

LOWER BIG RIVER SEWER DISTRICT
JEFFERSON COUNTY, MISSOURI



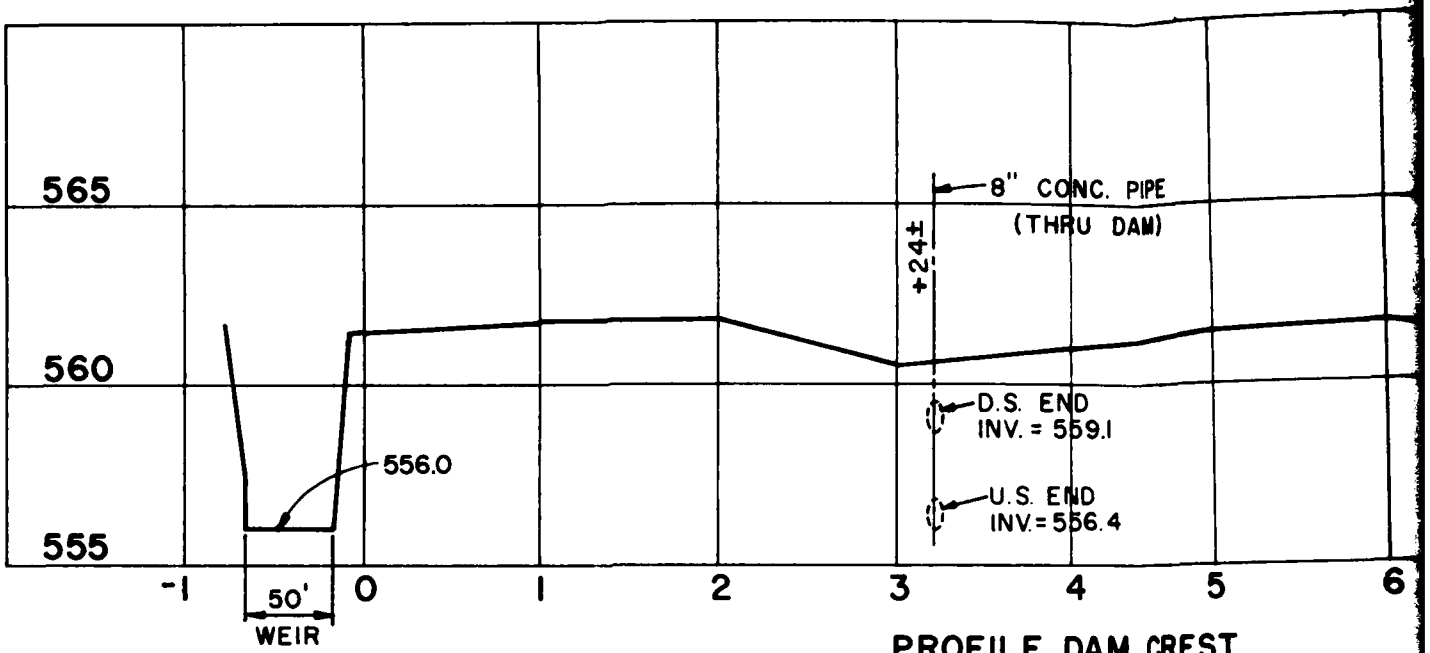
Dec. 1975

LAKE MONTOWESE

STRICT
URI

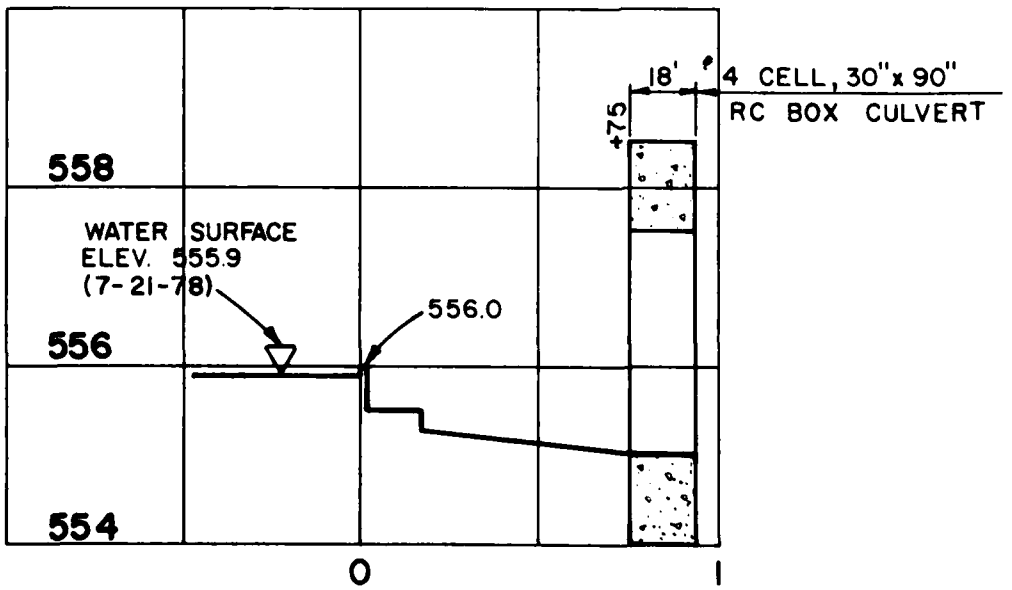
BORING DETAILS

PLATE 3



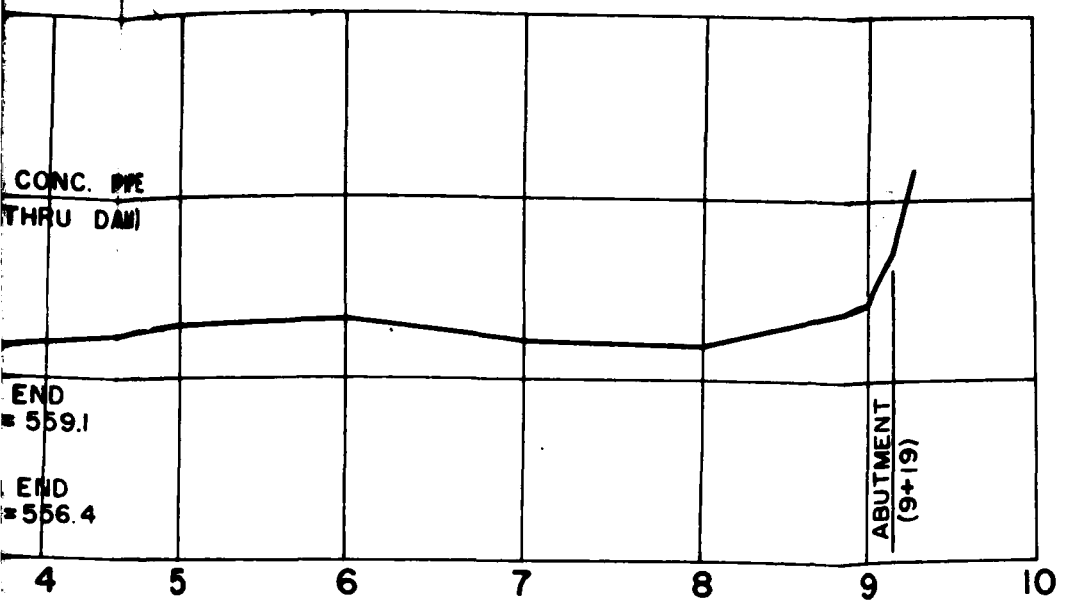
PROFILE DAM CREST

SCALES: 1"=5'V., 1"=100'H.



PROFILE SPILLWAY ℄

SCALES: 1"=2'V., 1"=50'H.



DAM CREST

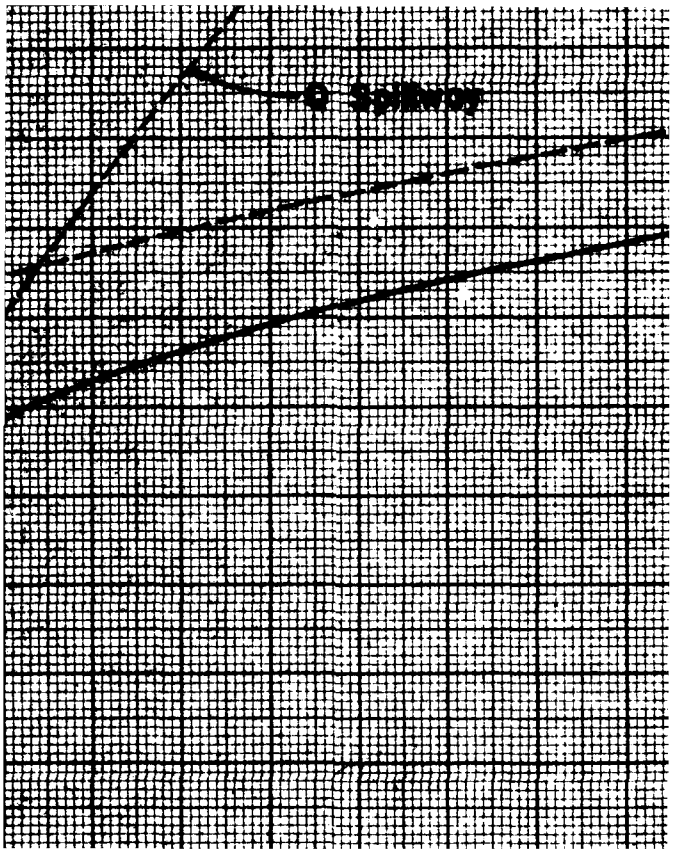
1"=5' V., 1"=100' H.

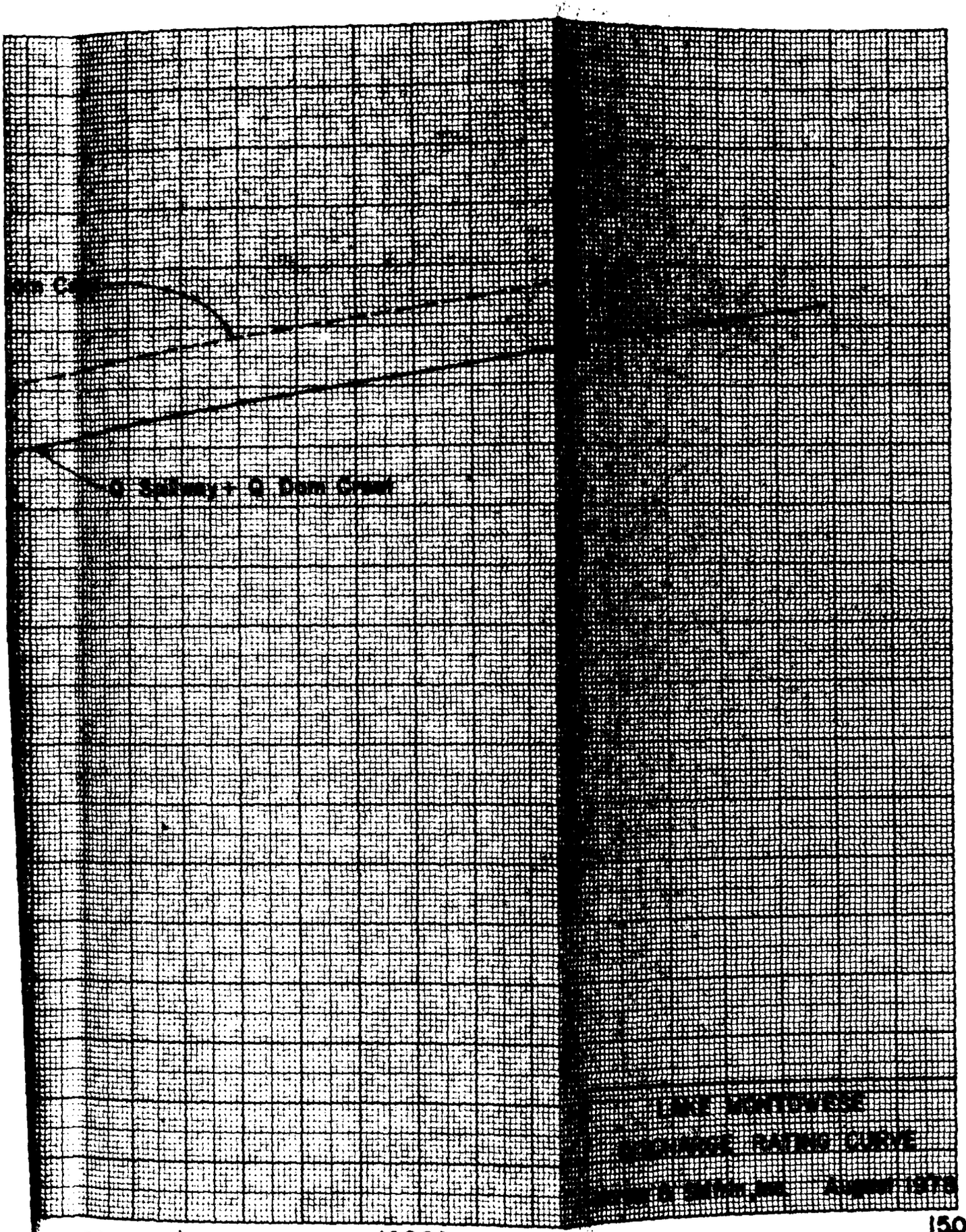
LAKE MONTOWESE

DAM & SPILLWAY PROFILES

Horner & Shifrin, Inc. August 1978

PLATE 4

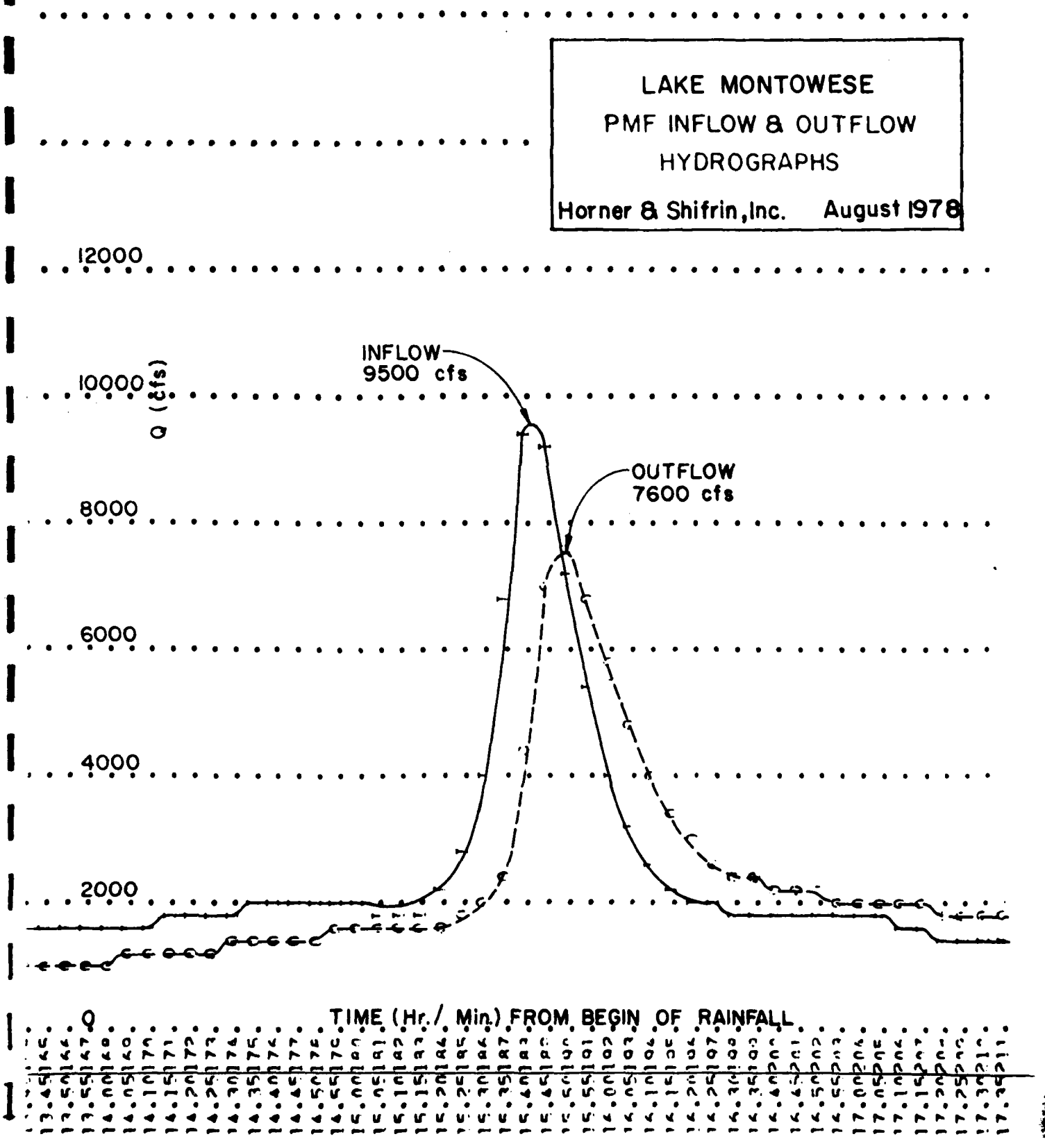

Q Solvay



LAKE MONTEVISTA
DISCHARGE RATING CURVE

PLATE 5

PLATE 6


LAKE MONTOWESE
PMF INFLOW & OUTFLOW
HYDROGRAPHS
Horner & Shifrin, Inc. August 1978
12000
10000
8000
6000
4000
2000
Q (cfs)
INFLOW
9500 cfs
OUTFLOW
7600 cfs
Q
TIME (Hr./ Min.) FROM BEGIN OF RAINFALL

ENGINEERING GEOLOGIC REPORT ON LAKE MONTOWESE, JEFFERSON COUNTY

LOCATION: NW1/4 sec. 27, T. 43 N., R. 4 E. (House Springs Quadrangle)

GEOLOGIC SETTING:

The lake is underlain by the St. Peter, a massive sandstone formation. An overlying rock formation, an interbedded shale and dolomite referred to as the Joachim, is present near the water line of the lake. The contact between the two rock formations occurs at 540 feet elevation, placing it some 15 feet below the spillway level.

SUITABILITY:

The general setting from the aspect of the geology for this lake is excellent. The St. Peter Sandstone is a massive rock formation. It does not have horizontal or vertical rock crevices or bedding planes; thus water movement through this rock formation is slow, approaching that of water movement through a dense sandstone, generally a few feet per year. The formation is relatively inert. Thus continual saturation with water will not cause deterioration, loss of strength, or increase the possibility of leakage. The overlying formation, the Joachim, is a mixture of dolomite and shale. It too, is a relatively impermeable formation and not affected by water saturation.

From surface appearances, construction procedures were excellent on the earthen dam. Maintenance completed by the owners of Lake Montowese subsequent to dam construction, has contributed materially to the generally excellent condition of the present dam. This refers particularly to the flattening of the backslope. The approximate gradient of the backslope is now 2-1/2:1. The second phase of maintenance, the placing of the stone riprap on the front portion of the dam, has also contributed toward the protection of the earthen structure.

RECOMMENDATIONS:

Recommendations center about three items. One refers to the problem of muskrats boring holes in the earthen dam. This should be halted since such holes could lead to leakage at a rapid rate and piping and removal of soil adjacent to the hole.

While the riprap appears adequate for wave protection, there are some sections where the stone has slumped or rolled somewhat below the permanent level of the water line. Consequently, it would be advisable to replace the stone as it slumps from its position near the permanent water level. Concrete that is used as riprap should vary in size so that a compacted layer of riprap can be obtained. The size ranges from boulders several feet in diameter down to sizes approximately six inches in diameter. Replacement material should be of the same size and quality as used in the original work.

The third suggestion would be spillway maintenance. This is perhaps the more important of the maintenance items at present. While there is no danger of

overtopping of the dam or destruction of the spillway by water erosion, a spillway that would offer greater protection than the one presently used, would enhance the general appearance of the lake as well as add to the spillway longevity. The present condition of the spillway shows the effect of the floodwater activity with general deterioration of the structures used in floodwater discharge. It is suggested that the construction of a concrete apron, possibly incorporating a trickle tube to discharge the daily flow, would reduce spillway deterioration over a period of years. The overflow or weir portion of the concrete apron would be utilized during more severe storms. The use of concrete in a spillway should be done under the guidance of a person experienced with this aspect of construction, particularly because the turbulence of floodwaters has sufficient energy to destroy structures that are insufficiently anchored or reinforced. In addition, the normal problems of seeping water under a water saturated spillway mean that eventually the base upon which the concrete rests will become saturated. Thus, drainage facilities should be provided so that freeze and thaw or uneven settlement does not result in the destruction of the spillway.

SUMMARY:

From the general setting of the dam and lake, the maintenance procedures have been excellent in contributing to the longevity of the structures. The most urgent problem that should be considered would be renovation of the spillway. A properly designed and constructed spillway would last for many years with a minimum of maintenance. The riprap should be replaced as needed and the muskrats should be removed. One other aspect not mentioned in the report, the vegetation on the backslopes of the dam should also be considered. There are a number of suitable grasses or matted root type plants that would be excellent. Long rooted plants or trees should be removed.

James H. Williams
Geologist and Chief
Engineering Geology
Missouri Geological Survey
March 23, 1970

Note: This report re-typed by
Horner & Shifrin, Inc.
to improve legibility.
(8/31/78)

ADDENDUM TO ENGINEERING GEOLOGIC REPORT ON LAKE MONTONESE
JEFFERSON COUNTY, MISSOURI

LOCATION: NW¼ sec. 27, T. 43 N., R. 4 E., (House Springs Quadrangle).

GEOLOGIC SETTING:

The lake as described in an engineering geologic report dated 23 March 1970, is for the most part underlain by the St. Peter Sandstone. At approximately 15 feet below waterline level the overlying bedrock formation, the Joachim Dolomite, is present. As noted in the original report, the St. Peter is a massive sandstone and relatively impermeable. What permeability exists, for the most part, is a slow water movement between sand grains. The overlying Joachim, also relatively impermeable, is made up of dolomite beds with thin shale layers between the more massive dolomite beds. Of the two formations, the Joachim normally is expected to have greater permeability, particularly along vertical fractures (joints) and horizontal parting planes.

A small spring, which is on the left (south) valley slope immediately downstream of the dam site, has it's source from the lake. The relatively cold water temperatures, at least 4 to 6 degrees below normal spring temperatures, indicate that this spring has it's source at a relatively great depth from the lake. Movement of water through the small parting planes within the near surface outcrops of the St. Peter Sandstone is not to the extent that these partings would be enlarged nor would be suspect of having loss of structural strength. Thus, there is no urgency nor concern from the geologic aspect that this leak would endanger the lake.

Downstream of the dam somewhat in the center of the valley, a water saturated zone exists which is separate from the seepage through the St. Peter Formation. This water saturated zone is considered more typical of that associated with an earthen fill. Since an earthen dam cannot be constructed as a completely water tight structure, water seepage through this fill gradually occurs as years progress in the history of a dam. It is customary to find this type of seepage unless some unusual condition, such as extremely flat or gentle gradient on the dam backslope has been constructed. Again, this is not believed to be a matter of serious concern inasmuch as the rate of water seeping through the soil is not increasing.

RECOMMENDATIONS:

The water flow from the bedrock fissure on the left (south) side of the valley immediately downstream of the dam, should be diverted with a channel diversion structure so that it does not merge with water seeping through the earthen fill. It is suggested that this channel diversion be constructed so that water will flow adjacent to the rock bluff for a short distance before directing this water flow through a gentle curve in the ditch to discharge at the existing road culvert. This would circumvent the relatively wet boggy area with the water channel diversion structure being constructed around this marshy zone.

The soft area which is supplied by water seeping through and possibly somewhat under the earthen fill can best be reduced, as far as a problem, by adding dirt to

portion of the dam. This would in effect continue to flatten the gradient of structure of the dam, thus, lengthening the path of seepage which the water would have to take as it gradually percolates through the earthen fill. Prior to being able to add dirt to this relatively soft area, it may be necessary to dig a temporary dewatering ditch, again, draining this toward the road culvert. However, if this is not possible, it is suggested that if relatively coarse material such as broken concrete or boulders can be obtained this could of course be added to the soft area. This would in effect not only give traction for vehicles to push dirt over this area, but also would add structural strength to the extreme downstream toe of the dam. The dirt should be spread in relatively thin lifts or layers with each passage of the bulldozer. This will both spread out the compacted dirt as well as increase the compaction of the material being added. If the dirt is dumped in deposits that are too thick, it is not possible to obtain adequate compaction. Typically, a dirt layer should be no more than one foot in thickness as it is spread by the bulldozer.

As noted in the original report it is most important that all trees be removed from the immediate structure of the dam. Essentially, this has been accomplished with perhaps one or two trees remaining near the spillway. Numerous case histories on dams exist where leakage has occurred through and along roots that extend from trees that have grown on the dam.

With reference to spillway renovation, this is perhaps the most single important item that deserves immediate attention. Basically, to obtain the most optimum spillway design, that is, the highest water level possible with relationship to the size of the watershed and the height between the water level and the dam, it is urged that the Lake Montowese Corporation obtain the advise of a consultant experienced in hydrology. The individual obtained should have experience in the design and construction of small lakes since this is a science, and perhaps art, that is quite distinct from that of hydrology with relationship to extremely large lakes or with major rivers. Basically, it is believed as noted in the original report, a trickle tube or relatively small pipe to carry the discharge caused by frequent rains should be installed. The construction of a concrete apron or possibly merely clearing the dirt that has accumulated in the spillway are alternates that could be discussed following the report by the hydrologist. From the standpoint of bedrock which is almost at the surface of the spillway, this is a durable rock and would suffice to serve as a spillway for occasional floods. However, it is not sufficiently competent to perform as a spillway discharge for continuous runoff. Freeze and thaw plus the normal deterioration of rock by flowing water will gradually destroy the integrity of the bedrock surface.

James H. Williams
Geologist and Chief
Engineering Geology Section
Missouri Geological Survey
August 30, 1971

ADDENDUM TO ENGINEERING GEOLOGIC REPORT ON LAKE MONTOWESE

Jefferson County, Missouri

Inspection of the dam on 20 April 1972, indicates that it retains the overall safe appearance as described in previous reports. The one single exception to this is the spillway. It is important that consideration be given to verification of spillway adequacy for major storms.

The maintenance, presently underway on the dam, is needed to assure that water saturated areas near the toe of the dam do not become so widespread that they would ultimately affect the safety of the structure. Collection of water flowing from the fissures in the rock bluff and channeling of this water, through a diversion ditch or subsequently in a drainage pipe, will adequately control this wetness problem that had developed at the downstream toe of the dam.

Removal of the rather dense growth of trees, particularly near the left (south) abutment slope, has contributed significantly toward improving the physical qualities of the dam. It is unfortunate that trees near a dam are a source of so much trouble, but the consequence of water loss along roots that seek out major sources of water, as for example the lake, is a common cause of leakage in earthen dams. Finally, the placement of dirt to improve surface drainage on the lower slope or toe of the dam, will complete the work needed in this area. In like fashion, the placement of some dirt at the moist area on the downslope toe on the right (north) abutment of the dam, would also facilitate both surface drainage as well as reducing an area of moisture accumulation which does contribute toward bgrowth of undesirable brush.

The opportunity to observe the seep or flow of water from the fissure in the sandstone bluff after the area has been cleaned, further indicates that the water source is from within the lake. There is sufficient hydrostatic pressure from the source of this water to carry particles of the overlying soil in suspension. This will not affect the structural integrity of the bedrock nor the safety of the dam.

In summary, work presently underway is precisely that which is needed to maintainas dam in sound condition. The only factor which merits additional attention is that of needed spillway improvements as noted in previous reports. The apparent inadequacies of the spillway result from normal deterioration of the original structure as well as the lack of capacity tohhandle the flow from a major storm. Statistically, a failure of a dam due to an inadequate spillway does not occur until some 20 to perhaps even 40 years after completion of the structure. This tends to bear out the theoretical frequency preditions of storms with a magnitude of a 25 year and 50 year intensities. Consequently, at the first opportunity an engineer familiar with the design and construction of spillways for medium sized earthen dams, should be consulted to determine both the need for improvement of this present spillway as well as to verify

or suggest enlargement of the spillway capacity to accomodate storm discharges. Previous references to the spillway need for spillway improvement, can be obtained by referring to early reports dated 27 March 1970 and 30 August 1971, written concerning the dam and lake at Lake Montowese.

James H. Williams
Geologist and Chief
Engineering Geology Section
Missouri Geological Survey
April 24, 1972

PRELIMINARY GEOLOGIC INVESTIGATION OF LAKE MONTOWESE

The apparent leakage on the right abutment of Lake Montowese was examined to see if any danger existed to the dam. The water that was running out of the dam was running clean and running into some trenches draining away from the toe of the dam and was apparently not doing any serious damage to the lake at the time of the visit. Due to the excessive wet winter and spring, it was difficult to tell exactly what the water was doing. It is best to keep thse open and to observed these throughout the summer, particularly during the drier portions of the year to see if they increase and to see if the level of the lake would go somewhat below the spillway elevation. Keep a close watch on the face of the dam to make sure no slippage takes place. If slippage is accomplished or is eminent, than by borrowing from an adjacent area and building a berm on the downstream face of the dam, this can be offset. However, if this is necessary, it should be accomplished with the proper engineering.

In the mean time there looks to be no apparent instability to the dam and little or no danger should occur from this dam failing. The biggest potential problem on the dam is the growth of trees that are starting to take place on the dam and these should be cut out as indicated by the maintenance people. Otherwise the dam looks to be in a very good condition.

E E L

Edwin E. Luzten, Geologist
Applied Engineering & Urban Geology
Missouri Geological Survey
July 11, 1973

MISSOURI
CHRISTOPHER S. BOND
GOVERNOR

DEPARTMENT OF
Natural Resources
JAMES T. WILSON
DIRECTOR

Wallace B. Howe, Director & State Geologist Division of Research & Technical Information

P. O. Box 250 Rolla, Missouri 65401 314 364 1752

Charles Chamberlin
6236 N. Lakeshore Drive
Rt. 1
House Springs, Missouri 63051

Dear Mr. Chamberlin:

I'm enclosing copies of reports we've written previously on Lake Montowese. The last paragraph on the report dated 3 August 1971 referred to some comments on the spillway. We would not be able to give engineering specifications for spillway renovation. Our function primarily is to note the geologic aspect of a lake particularly with reference to water holding possibilities or aid the owners in initial phases of study if some particular problem exists with the dam. When it comes to the aspect of engineering design, spillway construction and the like, that is in the role of the private consultant.

I would be glad to revisit the lake site if you would like, although I don't know if I could add much more information on the spillway. We have throughout the years stopped by the lake on occasions just to see how things are getting along. This stop might be for no other reason than the fact that Montowese seems to always be one of the better dams in the state with regards to maintenance and upkeep by the owners.

I would urge that you do have an engineering consultant at least visually inspect the spillway. I think he might offer you some thoughts that would save money in the long run. The history of problems with dams in the state of Missouri, and actually the history of problems of dams throughout the world relate more to spillway deficiencies or deterioration than to any other aspect of the structure. A spillway periodically will need more maintenance than the remainder of the dam.

Several consultants are available within the St. Louis area. You might contact, Layne-Western Company, Inc., 225 Grand Ave., Kirkwood, Mo. 63122, Gene Brucker, Brucker & Associates, 517 Selma Ave., Webster Groves, Mo. 63119, Don Lockmuller at PGA Engineers Incorporated, The Equitable Bldg., 10 Broadway, St. Louis, Mo. 63102, Fruco & Associates, 1706 Olive St., St. Louis, Mo. 63103, and Van A. Silver at McClelland Engineers Incorporated, Creve Coeur Executive Office Park, 744 Office Parkway, St. Louis, Mo. 63141.

Since we haven't been to Lake Montowese for a while and would be glad to stop in if we could assist further, I or someone in my section will check with you when next in the area.

Sincerely yours,

J. Hadley Williams, Chief
Applied Engineering & Urban Geology
Missouri Geological Survey

JHW:dh

Lake Montowese

Address Reply To:
Post Office Box 250
Rolla, Missouri 65401

May 16, 1975

Mr. Charles Chamberlin
6236 North Lakeshore Drive
Route #1
House Springs, Missouri 63051

Re: Lake Montowese Subdivision, Jefferson County, Missouri

Dear Mr. Chamberlin:

I visited Lake Montowese on 30 April and am sorry I could not make contact with you prior to my visit. The lake was nearly drained at the time of my visit with only a small pool visible. The dam certainly appears in good shape except for small mud slides caused by lowering of the water level on the upstream side of the dam. These small slides should have no consequence on the structural stability of the dam.

As per Mr. Jim Williams letter to you of April 3rd, I agree that a consultant should evaluate your spillway. Evidently the spillway has been revamped in past years numerous times. The total capacity of the spillway could well be sufficient if it were cleaned out and all the old structures removed.

The small spring on the left abutment should have no bearing on the stability of the dam, but rather be more of a nuisance feature. The spring is being fed from the lake and could probably be remedied by a drilling and grouting program if you thought necessary. No other features of a geologic nature were observed that might affect the lake.

Yours truly,

Thomas.J. Dean, Geologist
Applied Engineering & Urban Geology
Missouri Geological Survey

TJD:dh

Chart 2-10

FOR FILE ONLY

BB

ENGINEERING GEOLOGIC REPORT ON MONTOWESE LAKE

JEFFERSON COUNTY, MISSOURI

The lake was visited on 7 October 1976. At that time, water level was quite low with the lake being only 1/3 full. The lake had been drained to install sewer lines to eliminate septic tanks serving Lake Montowese residents. The front slope of the dam showed no signs of instability. The front slope was approximately 2½:1 becoming slightly steeper, 2:1 in the upper 7 feet. This portion has been riprapped, however, and also appears to be stable.

A question concerning the installation of a boat dock had been posed in a phone call during September 1976. There is no apparent problem to such a boat dock installation anywhere within the dam area, particularly near the flatter slopes adjoining the spillway. Ths spillway has been improved with repair of the concrete apron. Consequently, at present the overall lake site appears to be excellent geologically.

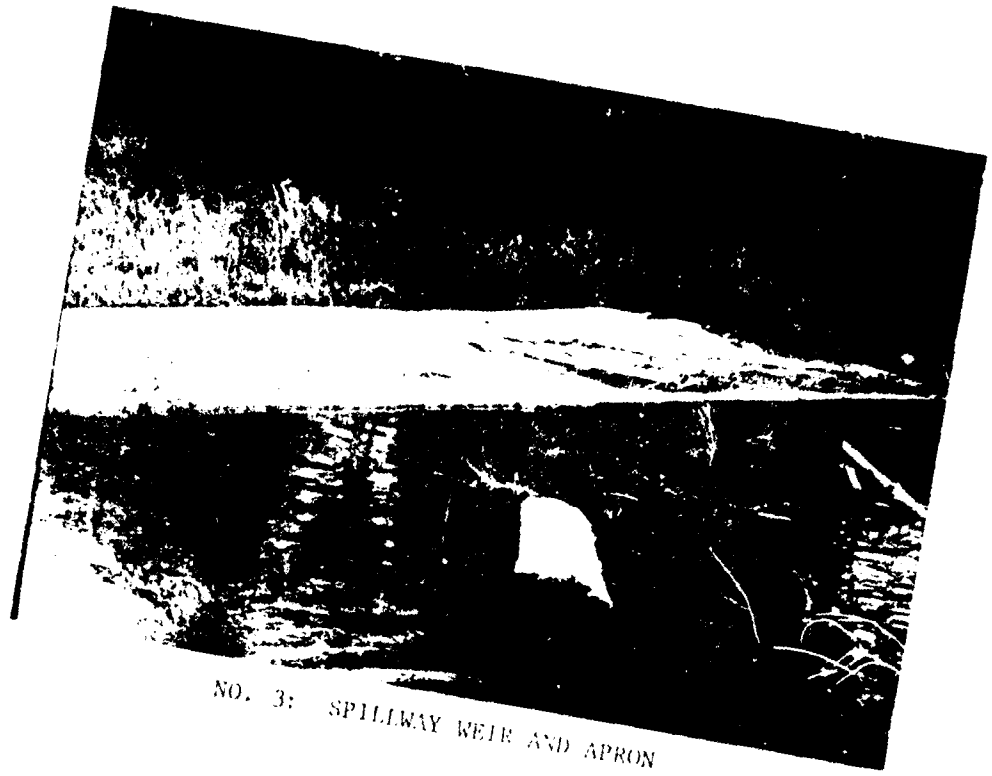
Dr. J.Hadley Williams, Chief
Applied Engineering & Urban Geology
Geology & Land Survey
October 8, 1976

Chart 2-11

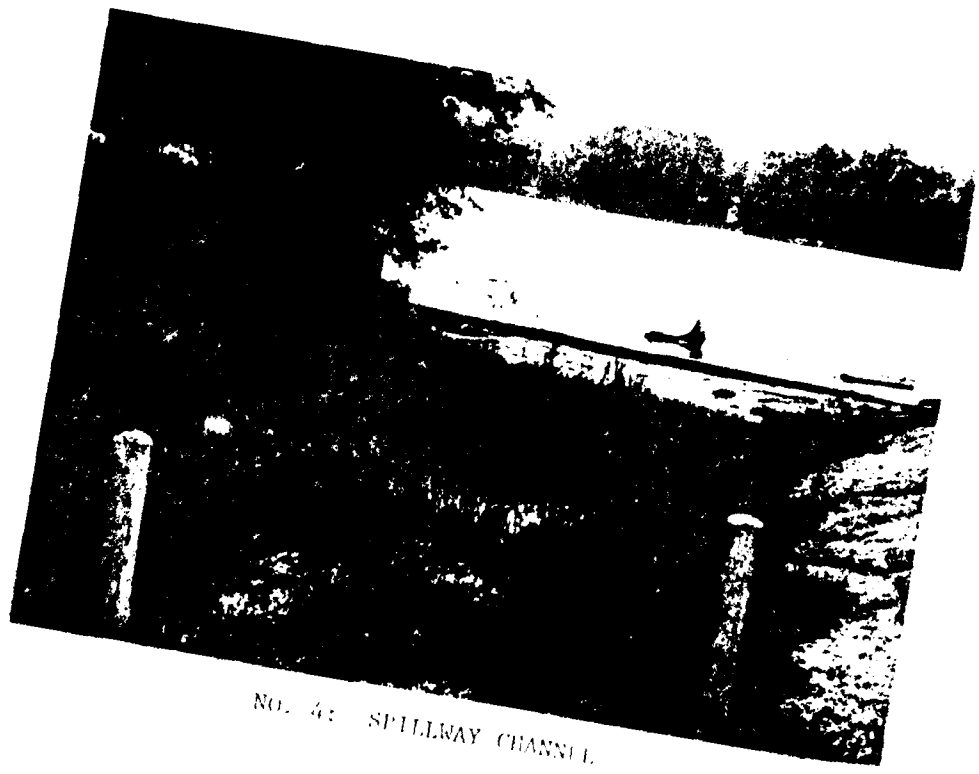
APPENDIX

NO. 1: UPSTREAM FACE OF DAM

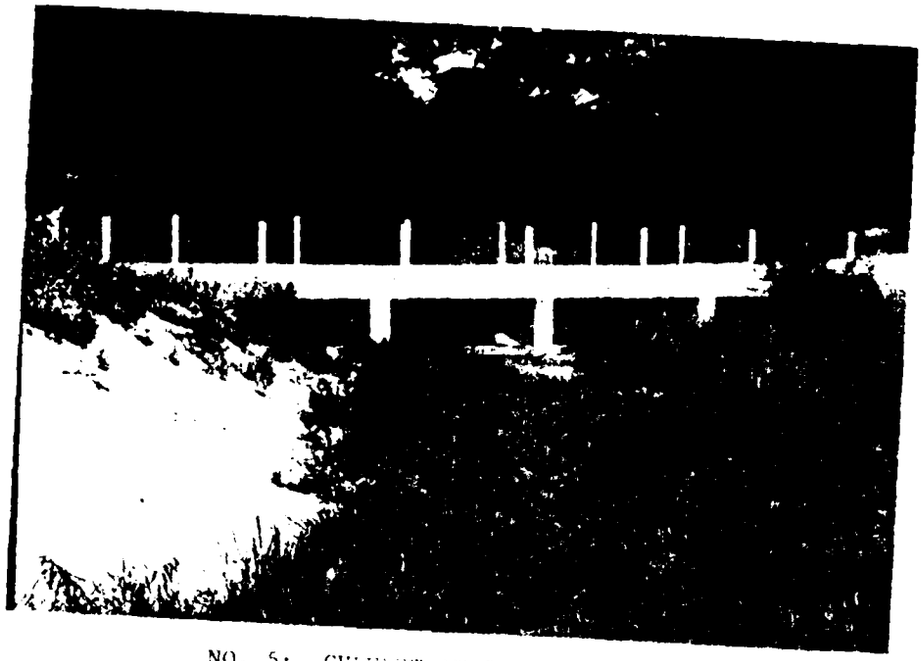
NO. 2: DOWNSTREAM FACE OF DAM



NO. 3: SPILLWAY WEIR AND APRON



NO. 4: SPILLWAY CHANNEL



NO. 5: CULVERT AT SPILLWAY CHANNEL

NO. 6: SPILLWAY OUTLET CHANNEL

NO. 7: POND IN AREA BELOW DAM

HYDROLOGIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hr. value equals 25.6 inches) from Hydrometeorological Report No. 33, one hundred year frequency (one square mile precipitation, 24-hr. value equals 7.22 inches) from the U.S. Weather Bureau Technical Paper No. 40.

b. Drainage area = 0.78 square miles
= 500 acres

c. SCS parameters
Lag time = 0.16 hours
Soil type CN = 80

2. The spillway section consists of a broad-crested, approximately U-shaped concrete and rock section for which conventional weir formulas do not apply.

Spillway release rates were determined as follows:

(1) Spillway crest section properties (area, a and top width, t) were computed for various depths, d.

(2) It was assumed that flow leaving the spillway crest would occur at critical depth. Flow at critical depth (Q_c) was computed as $Q_c = (\frac{a^3}{t} g)^{0.5}$ for the various depth, d.

Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.

(3) Static lake levels corresponding to the various Q_c values passing over the spillway were computed as critical depths plus critical velocity head ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

3. The profile of the dam crest is irregular and flow over the dam crest cannot be determined by conventional weir formulas. Flow quantities overtopping the dam crest were computed as described in the preceding paragraph and corresponding flow over the dam and spillway for given elevations were added to obtain the combined outflow rating curve for the dam and spillway. This rating curve is shown on Plate 5. The inflow and outflow hydrographs for the PMF are shown on Plate 6.

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
    1                 AI       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2                 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE MONTOWESE DAM
    3                 A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
    4                 B     288        0        5       -0       -0       -0       -0       -0       -0       -0
    5                 B1      5
    6                 J       1        3        1
    7                 JI   0.45     0.50     1.00
    8                 K       0   INFLOW                                    3        1
    9                 K1       INFLOW HYDROGRAPH
   10                 H       1        2    0.78                                                          1
   11                 D       0     25.6      102      120      130
   12                 T                                                              -1      -80
   13                 H2              0.16
   14                 X    -1.0     -.10      2.0
   15                 K       1      DAM                          2        3        1
   16                 K1       RESERVOIR ROUTING BY MODIFIED PULS
   17                 V                                        1        1
   18                 V1      1                                                    606       -1
   19                 V4    556    556.5      557    557.5      558    558.5      559    559.5      560    560.5
   20                 V4  560.9    561.4    561.5      562    562.5      563    563.5      564
   21                 V5      0       70      170      290      450      630      830     1050     1300     1570
   22                 V5   1440     2460     2660     4220     6600     9430    12810    16550
   23                 SA      0     40.4     46.8     62.4     79.0
   24                 SE    511      556      560      570      580
   25                 SS    556
   26                 SD  560.5
   27                 K      99
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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 3 AUG 78
****

1	A1	ANALYSIS OF DAM OVERTOPPING USING 100 YR FLOOD									
2	A2	HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE MONTOWESE DAM									
3	A3	100 YR FLOOD ROUTED THROUGH RESERVOIR									
4	B	288	0	5	-0	-0	-0	-0	-0	-0	-0
5	B1	5									
6	J	1	1	1							
7	J1	1.0									
8	K	0	INFLOW				1	1			
9	K1		INFLOW HYDROGRAPH								
10	M	0	2	0.73			1.0			1	
11	O	288									
12	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
13	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
14	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
15	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
16	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
17	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
18	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
19	O1	.007	.007	.014	.014	.014	.014	.014	.014	.014	.014
20	O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
21	O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
22	O1	.014	.014	.014	.014	.014	.014	.014	.014	.022	.022
23	O1	.022	.022	.022	.022	.022	.022	.022	.022	.022	.022
24	O1	.022	.022	.022	.022	.022	.022	.031	.031	.031	.031
25	O1	.031	.031	.061	.061	.061	.061	.061	.061	.132	.132
26	O1	.132	.251	.251	.550	.823	.382	.251	.133	.132	.132
27	O1	.061	.061	.061	.061	.061	.061	.031	.031	.031	.031
28	O1	.031	.031	.022	.022	.022	.022	.022	.022	.022	.022
29	O1	.022	.022	.022	.022	.022	.022	.022	.022	.022	.022
30	O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
31	O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
32	O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
33	O1	.014	.014	.014	.014	.014	.014	.007	.007	.007	.007
34	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
35	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
36	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
37	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
38	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
39	O1	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
40	O1	.007	.007	.007	.007	.007	.007	.007	.007		

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40          J1   .007    .007    .007    .007    .007    .007    .007    .007
41          T                                                    -1      -80
42          J2          0.15
43          X   -1.0    -.10    2.0
44          K      1    DAM                     2       3       1
45          K1      RESERVOIR ROUTING BY MODIFIED PULS
46          X                           1       1
47.         X1      1                                           606     -1
48          X4    556   556.5    557    557.5    558    558.5   559    559.5    560    560.5
49          X4  560.0   561.0   561.5    562    562.5    563   563.5    564
50          X5      0      70     170     290     450     630     830    1050     1300    1570

B-5

51          X5   1340    2460    2660    4220    6600    9430   12810   16550
52          SA      0    40.4    46.8    62.4    79.0
53          SF    511     556     560     570     580
54          $$    556
55          $0  560.5
56          K     00
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